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09/418,818	10/15/1999	DAVID CHEUNG	AM1084D01/T9	9377

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EXAMINER	
ZERVIGON, RUDY	
ART UNIT	**PAPER NUMBER**
1763	12

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Please find below and/or attached an Office communication concerning this application or proceeding.

T-D-12

Office Action Summary	Application No. 09/418,818	Applicant(s) CHEUNG et al
	Examiner Rudy Zervigon	Art Unit 1763

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on *Mar 11, 2002*

2a) ☒ This action is **FINAL.** 2b) ☐ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) *1-10 and 44-62* is/are pending in the applica

4a) Of the above, claim(s) ______ is/are withdrawn from considera

5) ☐ Claim(s) ______ is/are allowed.

6) ☒ Claim(s) *1-10 and 44-62* is/are rejected.

7) ☐ Claim(s) ______ is/are objected to.

8) ☐ Claims ______ are subject to restriction and/or election requirem

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☐ The drawing(s) filed on ______ is/are objected to by the Examiner.

11) ☐ The proposed drawing correction filed on ______ is: a) ☐ approved b) ☐ disapproved.

12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

a) ☐ All b) ☐ Some* c) ☐ None of:

1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ______ .
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

*See the attached detailed Office action for a list of the certified copies not received.

14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

15) ☐ Notice of References Cited (PTO-892)

16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s). ______

18) ☐ Interview Summary (PTO-413) Paper No(s). ______

19) ☐ Notice of Informal Patent Application (PTO-152)

20) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

2. Claims 44, 45, and 62 are rejected under 35 U.S.C. 102(b)[1] as being anticipated by Felts et al (USPat. 4,888,199) as demonstrated by M.K. Puchert, et al[2]. Felts et al (USPat. 4,888,199) teaches a PECVD process control and equipment (column 4, lines 8-31) where:

i. 44. A substrate processing system, comprising:

ii. a process chamber (item 11, Figure 1;col.4,lines 8-31 - both Felts et al);

iii. a substrate support (item 53, Figure 2;col.4,lines 48-60), located within the vacuum chamber, for supporting a substrate (item 13, Figure 1,2)

iv. a power supply (item 17, Figure 1,2;col.3,line 61-65)

v. a gas delivery system (item 15, Figure 1,2;col.3,lines 59--61) for delivering process gases (col.5,lines 3-40) into the process chamber ;

vi. a controller (item 27, Fig.1;col.5,line 27 through the end of the patent) configured to control the power supply (item 17, Figure 1,2;col.3,line 61-65,Both Felts et al) and the gas delivery system ;

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[1]M.P.E.P. - 2121.01(a)

[2]M.K. Puchert, et al, "Gas-plasma interactions in a filtered cathodic arc", *J. Vac.Sci.Technol. A* **10**(6), Nov./Dec. <u>1992</u>, pp.3493-3497

vii. a memory (column 10, lines 56-64) coupled to the controller comprising a computer readable program (column 16 - column 46- Felts et al 4,888,199) having a computer readable program embodied therein for directing operation of the substrate processing system, the computer readable program including a first (column 5, lines 16-40) set of computer instructions (column 16 -column 46 - Felts et al- 199) for controlling the gas delivery system to introduce selected deposition gases (column 5, lines 17-40) into the process chamber at deposited gas flow rates,

viii. a second (column 10, lines 47-50; col.31 - Felts et al 4,888,199) set of computer instructions for controlling the gas delivery system to add a flow of an inert gas ("He",column 10, lines 47-50; col.31) to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases , the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas , and a third set of computer instructions for controlling the power supply to supply power to the process chamber to produce a plasma enhanced reaction of the deposition gases in the process chamber to deposit a film at the low deposition rate.

Felts et al (USPat. 4,888,199) anticipates the claimed relationship of deposition rates and the presence of an inert gas with added appreciation to the Felts et al (USPat. 4,888,199) discussion:

Claimed:

$D_{-IG} > D_{+IG}$

Where D represents "deposition rate", "-/+" represents without (-) or with (+) inert gas (IG). With the addition of an IG (He) the partial pressures of all "selected deposition gases" will diminish and effectively "lower" or reduce the deposition rate. In addition, as discussed by Felts et al (USPat. 4,888,199), the addition of He increases electron density in the plasma (column 10, lines 47-50) which anticipates the effect of reduced deposition rates considering the fact that these added electrons would effectively shield cations thereby reducing one of the chemical mechanisms of PECVD.

That the relationship between plasma vapor deposition and He electron density is known is further demonstrated by M.K. Puchert, et al: III c

M.K. Puchert et al state (section IIc. - "Deposition Rate", lines 4-5) that the copper deposition rate decreases "as the pressure and the ion current increase" (Figure 2, 4). Peripherally, M.K. Puchert et al *supports* the physical theory supplied by the Examiner - "The fact that the deposition rate on axis <u>falls</u> to zero supports the view that the observed increase in the ion current is primarily due to an increase in the <u>density of gas ions</u>.". In addition, see below - "Response to Arguments". Fig. 6

Claim Rejections - 35 USC § 103

3. The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

4. Claims 1 and 7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 5,365,665). Felts et al (USPat. 5,365,665) describes a substrate (item13;Fig.2;col.5,lines50-64) processing system (item 10, Figure1;col.5,lines51-64), comprising:

ix. a vacuum chamber (item 11, Figure1;col.5,lines51-64); a substrate supporter (item32,42a,b;Fig.2;col.6,lines49-66), located within the vacuum chamber, for holding a substrate

x. a gas manifold (item15;Fig.1;col.6,line31) for introducing process gases (col.5, lines 10-20,32-43) into the chamber

xi. a gas distribution system ("Flow Controller (item 27; col.6,lines13-20)";Fig.2;col.6), coupled to the gas manifold , for distributing the process gases to the gas manifold from gas sources;

xii. a power supply (item 17, Fig.1,2;col.5, line 65-20,32-col.6,line 5) coupled between the substrate supporter and the gas manifold

xiii. a vacuum system (item 19, Fig.1,2; col.6,lines1-5) for controlling pressure (col.6,lines1-5) within the vacuum chamber

xiv. a controller (item 27; col.6,lines13-20), including a computer (col.6, lines 13-20), for controlling the gas distribution system , the power supply and the vacuum system

xv. a memory ("including a computer controlled portion..and send controlling commands to them"; column 6, lines 6-20) coupled to the controller comprising a computer readable medium having a computer readable program code (implicit, col.6, lines 13-20) embodied therein for directing operation of the substrate processing system , the computer readable program code including:

xvi. computer readable program code for causing the gas distribution system to introduce a first process gas comprising a mixture of organosilanes -SiH_3 (col.1,line20; organosilanes containing -SiH_3 - col.5, lines1-6) and N_2O (col5,lines 37-42;col.1,line 21) into the chamber to deposit a first plasma enhanced CVD (col.1,lines10-14) layer over the wafer (Fig.2,item 13)

xvii. A computer readable program code for causing the gas distribution system to introduce a second process gas comprising He (col.5,lines 13-20, 42) into the chamber to control the deposition rate of the first layer

xviii. 7. A substrate processing system as in claim 1 further comprising computer readable program code for controlling the gas distribution system to operate for a specified time period

Felts et al (USPat. 5,365,665) does not precisely describe a first process gas comprising a mixture SiH_4, however Felts et al (USPat. 5,365,665) does teach its use as an alternative (col. 1,line 20).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to introduce a first process gas comprising a mixture of SiH_4 and N_2O into the chamber to deposit a first plasma enhanced CVD layer over the wafer .

Motivation for introducing a first process gas comprising a mixture of SiH_4 and N_2O into the chamber to deposit a first plasma enhanced CVD layer over the wafer is drawn from the very teachings of Felts et al (USPat. 5,365,665) which discuss the use of silane gas as precursor for films (col. 1,lines 10-20).

5. Claims 2-6, 9, 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 5,365,665), as applied to claims 1 and 7 above, and further in view of Thomas S. Dory (U.S. Pat, 4,877,641). Felts et al (USPat. 5,365,665) additionally teaches:

xix. 2. a mixture of SiH_4 (col.1,line20; organosilanes containing SiH_4 - col.5, lines1-6) and N_2O into the chamber controls the introduction of the SiH_4 to be between 500 to 1000 sccm, and the rate of N_2O to be undisclosed.

xx. 3. A (total) chamber pressure at about < 0.1 torr (column 6,line 4)

xxi. 5. a fourth process gas comprising N_2 (col.5,lines 32-42) into the chamber (column 3,lines 30-50)

Felts et al (USPat. 5,365,665) does not teach

xxii. SiH_4 flow to be between 5 to 300 sccm, and the rate of N_2O to be between 5 to 300 sccm.

xxiii. chamber controls where the total chamber pressure at about 1 to 6 torr

xxiv. the chamber controls where the introduction of the SiH_4 to be at a ratio of between 0.5 to 3 times the amount of N_2O.

xxv. a third process gas comprising NH_3 (col.1,lines 20-23) into the chamber;

xxvi. a third process gas comprising NH_3 into the chamber to be between a rate of 0 to 300 sccm; and

xxvii. a fourth process gas comprising N_2 into the chamber to be between a rate of 0 to 4000 sccm

Thomas S. Dory teaches a plasma enhanced CVD process for forming silicon nitride or silicon dioxide films on substrates (column 1; lines 15-61). Specifically, Thomas S. Dory teaches a gas distribution system (column 3, lines 14-30) to introduce the first process gas comprising a mixture of SiH_4 (col.1,lines 27-28), or alternatives (col.1,lines 36-58), and N_2O (col.3,lines31-44) into the chamber controls where the introduction rate of N_2O is between 5 to 300 sccm (col.3,line 41). Additionally, Thomas S. Dory teaches chamber controls of the (total) chamber pressure at about 1 to 6 torr (col.4,lines 10-11). Thomas S. Dory also teaches the gas distribution system to introduce a fourth process gas comprising N_2 into the chamber (col.3,lines 35-45;col.4,lines 5-6).

Thomas S. Dory also teaches introducing a third process gas ("gas or gases" - col.3,line 35) comprising NH_3 (col.4,lines 3-4) into the chamber where the introduction of the NH_3 (col.3,lines 35-37) to be between a rate of 0 to 300 sccm (col.3, line 40); and the introduction of the N_2 to be between a rate of 0 to 4000 sccm (col3.line 41).

Thomas S. Dory additionally teaches NH_3 gas introduced into the chamber at a rate of less than 150 sccm (col.3,lines 39-42) and a fourth process gas comprising N_2 introduced into the chamber at a rate of less than 300 sccm (col.3, line 40).

Thomas S. Dory and Felts et al (USPat. 5,365,665) each do not teach gas flow rates of between 15 to 160sccm for both N_2O gas and SiH_4 gases. Felts et al (USPat. 5,365,665) does not teach gas comprising NH_3 introduced into the chamber at a rate of less than 150 sccm and a fourth process gas comprising N_2 introduced into the chamber at a rate of less than 300 sccm.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to vary the introduction rate of N_2O as being between 5 to 300 sccm as taught by Thomas S. Dory as the preferred introduction rate of N_2O in the Felts et al (USPat. 5,365,665) substrate processing system.

Motivation for varying the introduction rate of N_2O as being between 5 to 300 sccm in the Felts et al (USPat. 5,365,665) substrate processing system is drawn from the Thomas S. Dory discussion - "control of film properties, as expressed by the refractive index (N_f)." (Col.3, lines 45-48), and "Thus for a given pressure and DTBS flow rate, increasing or decreasing the NH_3, N_2, N_2O, or NO flow rate changes the Nf of the film." (Column 3,lines 48-51).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to select the preferred chamber controls of the (total) chamber pressure at about 1 to 6 torr as taught by Thomas S. Dory as the preferred chamber controls of the Felts et al (USPat. 5,365,665) substrate processing system.

Motivation for selecting the preferred chamber controls of the (total) chamber pressure at about 1 to 6 torr as taught by Thomas S. Dory as the preferred chamber controls of the Felts et al (USPat. 5,365,665) substrate processing system is drawn from the discussion of Thomas S. Dory where "Thus this *control* of the relative flow rates of the reactants and the *pressure* permits precise *control* of the film properties." (Column 4, lines 27-29).

The flow rate range of SiH_4 discussed by Felts et al (USPat. 5,365,665) to be between 500 to 1000 sccm, and flow rate range of N_2O as discussed by Dory as being between 5 to 300 sccm provides for the following range of flow rate ratios:

Thomas S. Dory:

200 - 4000sccm N_2O (col3.line 41)

Felts et al (USPat. 5,365,665):

500 - 1000sccm silane as alternative (col.5,lines40-41)

$$500/4000 = 1/8 \leq \frac{SiH_4}{N_2O} \leq 1000/200 = 5$$

6. Claims 46-48 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 4,888,199) as applied to claims 44, 45, and 62 above, and further in view of Felts et al (USPat. 5,365,665). Felts et al (USPat. 4,888,199) teaches selected deposition gases as discussed above. However, Felts et al (USPat. 4,888,199) does not teach:

xxviii. 46. deposition gases comprising silane and an oxygen source.

xxix. 47. deposition gases comprising silane and nitrous oxide.

xxx. 48. deposition gases comprising silane and a nitrogen source.

Felts et al (USPat.5,365,665) teaches:

xxxi. 46. deposition gases comprising silane (col.1,lines19-23) and an oxygen source

xxxii. 47. deposition gases comprising silane and nitrous oxide (column 5, lines 37-40)

xxxiii. 48. deposition gases comprise silane and a nitrogen source (col.5,lines 32-42)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to implement the Felts et al (USPat. 5,365,665) deposition gases as process gases in the Felts et al (USPat. 4,888,199) invention.

Motivation for implementing the Felts et al (USPat. 5,365,665) deposition gases as process gases in the Felts et al (USPat. 4,888,199) invention is drawn from the desired film for deposition (column 5,lines 43-50) and the effect on the deposition rate (column 5,lines 32-40) and hardness (column 4, lines 47-50).

7. Claims 49-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 4,888,199) in view of Felts et al (USPat. 5,364,665), as applied to claims 46-48 above, and further and Thomas S. Dory (U.S. Pat, 4,877,641).

Felts et al (USPat. 4,888,199) describes:

xxxiv. 50. A substrate processing system of claim 49 further comprising a heater (col.14,line 61-col.15,line 7) for heating the substrate, and wherein the computer-readable program further comprises a fifth set of computer instructions for controlling the heater to heat the substrate. Felts et al (USPat. 4,888,199) teaches "...**240** adapted to maintain heated layer **234** at a temperature above the boiling point of the liquid ... with a boiling point of 55.5°C, and ... with a boiling point of 127°C"

Felts et al (USPat.5,364,665) teaches selected deposition gases as described above. Additionally, Felts et al (USPat.5,364,665) teaches:

xxxv. 49. a vacuum system (19,all Figures) for controlling pressure within the process chamber, and a computer-readable program (column 6,lines 13-20)

xxxvi. 51. The substrate processing system of claim 50 wherein the substrate support is spaced "Δ" (column 6,line 62-col.7,line 10) from the gas distribution system at a distance in the range of 200-600 mils = 0.2-0.6 inches, where "mils" is interpreted as "milli-inches" - "Distance Δ should be no greater than about 12 inches..." or - Δ < 12"

Felts et al (USPat. 4,888,199) and Felts et al (USPat. 5,364,665) do not teach:

xxxvii. a chamber pressure in the range of 1-6Torr

xxxviii. silicon depositing gasses flowed into the chamber at a rate of 5-300 sccm and N_2O flowed into the chamber at a rate of 5-300 sccm

xxxix. a heater to heat the substrate to a temperature in the range of 200-400°C

xl. NH_3 flowed into the chamber at a rate of less than 300 sccm and N_2 flowed into the chamber at a rate of less than 4000 sccm

xli. RF power supply to supply power of 50-500 Watts to the process chamber

Thomas S. Dory teaches:

xlii. 49. controlling the vacuum system to maintain a chamber pressure in the range of 1-6Torr (col.4,lines 10-11), and wherein the selected deposition gases (column 3, lines 31-59) comprise silicon depositing gasses (column 1, lines 27-58;col.3,lines31-33) flowed into the chamber at a rate of 5-300 sccm (col.3;lines31-33) and N_2O flowed into the chamber at a rate of 5-300 sccm (col.3;line41)

xliii. 50. A substrate processing system of claim 49 further comprising a heater (col.2,line68-col.3,line 3) for heating the substrate, and controlling the heater to heat the substrate to a temperature in the range of 200-400°C (column 3, lines 4-13).

xliv. 52. A substrate processing system of claim 49 wherein the selected deposition gases (column 1, lines 36-60) further comprise NH_3 (col3,lines 40-41) flowed into the chamber at

a rate of less than 300 sccm (Col.3;lines 31-33), and N_2 flowed into the chamber at a rate of less than 4000 sccm (col.3, line 40)

xlv. RF power supply to supply power of 50-500 Watts (col.3, line 65 - col.4, line 11) to the process chamber

It would have been obvious to one of ordinary skill in the art at the time the invention was made to implement the temperature control computer-readable program as discussed by Felts et al (USPat.5,364,665) and Felts et al (USPat. 4,888,199) who describe computer-readable program comprising a set of computer instructions for controlling the heater to heat the substrate as part of the Dory et al PECVD processing techniques (col.1,lines 23-61).

Motivation for implementing the temperature control computer-readable program , as discussed by Felts et al (USPat.5,364,665), and Felts et al (USPat. 4,888,199) is directed to Dory et al's PECVD processing techniques centered on "isothermal" processing (col.3,lines 4-13).

8. Claims 53-59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 5,364,665), in view of Felts et al (USPat. 4,888,199) and Thomas S. Dory (U.S. Pat, 4,877,641). Felts et al (USPat. 5,364,665, and 4,888,199) each teach the claimed invention as described above. However both Felts et al (USPat. 5,364,665, and 4,888,199) do not teach:

xlvi. flowing SiH_4 at a flow rate of 5-300 sccm into the process chamber

xlvii. Nitrous oxide gas

xlviii. the combined flow rate of SiH_4 and N_2O of at least 6.25:1

xlix. total chamber pressure at about 1 to 6 torr

In addition to what Thomas S. Dory teaches as described above, Thomas S. Dory also teaches:

l. flowing SiH_4 (col.1, line 27) at a flow rate of 2-4000 sccm (column 3, line 34) into the process chamber

li. Nitrous gas - (column 4, lines 12-21)

Both Felts et al (USPat. 5,364,665, and 4,888,199) and Thomas S. Dory do not teach:

.....wherein a ratio of the selected flow rate of He to the combined flow rate of SiH_4 and N_2O is at least 6.25:1 to deposit an antireflective layer on the substrate at a deposition rate which is lower than a deposition rate using the same flow rate of SiH_4 and the same flow rate of N_2O with a lower flow rate of He.

Felts et al (USPat. 4,888,199) anticipates the claimed relationship of deposition rates and the presence of an inert gas with added appreciation to the Felts et al (USPat. 4,888,199) discussion as elaborated above (See "Claimed:").

It would have been obvious to one of ordinary skill in the art at the time the invention was made to increase the ratio taught by Felts et al (USPat. 5,365,665) to meet the combined flow rate of SiH_4 and N_2O of at least 6.25:1.

Motivation for increasing the taught ratio taught by Felts et al (USPat. 5,365,665) to meet the combined flow rate of SiH_4 and N_2O of at least 6.25:1 is drawn from the Thomas S. Dory discussion - "control of film properties, as expressed by the refractive index (N_f)." (Col.3, lines 45-48), and "Thus for a given pressure and DTBS flow rate, increasing or decreasing the NH_3, N_2, N_2O, or NO flow rate changes the Nf of the film." (Column 3,lines 48-51). Additionally, apparatus claims must be structurally distinguishable from the prior art. See MPEP 2114. Additionally, it is applicant's burden to prove the established results are unexpected and significant. See MPEP 716.02(b)[3].

It would have been obvious to one of ordinary skill in the art at the time the invention was made to select the preferred chamber controls of the (total) chamber pressure at about 1 to 6 torr as taught by Thomas S. Dory as the preferred chamber controls of the Felts et al (USPat. 5,365,665) substrate processing system.

Motivation for selecting the preferred chamber controls of the (total) chamber pressure at about 1 to 6 torr as taught by Thomas S. Dory as the preferred chamber controls of the Felts et al (USPat. 5,365,665) substrate processing system is drawn from the discussion of Thomas S. Dory where "Thus this *control* of the relative flow rates of the reactants and the *pressure* permits precise *control* of the film properties." (Column 4, lines 27-29).

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[3]In re Boesch , 617 F.2d 272, 205 USPQ 215 (CCPA 1980)

9. Claims 8, 60, and 61 are rejected under 35 U.S.C. 103(a) as being unpatentable over Felts et al (USPat. 5,364,665), as applied to claims 1 and 7 above, and further in view of Fourmun Lee (U.S. Pat. 5,286,581). Felts et al teaches a substrate processing system as discussed above including deposition gas and inert gas flow rate/ratio control and logic as explained above. However, Felts et al does not teach:

lii. means for forming a layer of photoresist on the antireflective layer, the antireflective layer having a thickness and refractive index such that a first reflection from an interface between the photoresist and the antireflective layer of an exposure light will be an odd number which is at least 3 multiplied by 180° out of phase with a second reflection from an interface between the antireflective layer and the substrate layer of the exposure light; and means for forming a photoresist pattern by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

liii. A silicon oxynitride antireflective layer with refractive index in 1.7-2.9 and absorptive index in 0-1.3 and a thickness of 200-3000Å and an light exposure wavelength of 365nm or less.

Fourmun Lee does teach:

liv. means for forming a layer of photoresist (14, Fig.1;column 3, line 65- col.4, line 5) on the antireflective layer (13, Fig.1;column 3, lines 46-64), the antireflective layer (13, Fig.1;column 3, lines 46-64) having a thickness ("d", col.5, lines 10-15) and refractive index ("n", col.5, lines 10-15) such that a first reflection from an interface between the photoresist and the antireflective layer of an exposure light ("L", col.5, lines 10-15) will be an odd

number (1, in this case; column 5, line 6) which is not at least 3 multiplied by 180° (π in radians) out of phase with a second reflection from an interface between the antireflective layer and the substrate layer (12', 13'; column 5, lines 5-10) of the exposure light; and means for forming a photoresist pattern (column 5, lines 52-57) by exposing the photoresist layer to the exposure light and developing the exposed photoresist layer.

lv. A silicon nitride and silicon oxynitride antireflective layer (12', 13'; column 5, lines 20-30; column 3, line 49) with refractive index in 1.7-2.9 (2.05, column 5, line 27) and a thickness of 200-3000Å (1,738Å; column 5, line 27) and an light exposure wavelength of 365nm or less (column 5, line 24).

Although Fourmun Lee teaches only nπ radians, where n=1, out of phase between consecutive areas 12' and 13', it would have been obvious to one of ordinary skill in the art at the time the invention was made to realize that odd multiples of π radians is the same phase angle.

Although Fourmun Lee does not mention the absorptive index of the antireflective layer for a silicon oxynitride material, it is the position of the examiner that the absorptive index of silicon oxynitride for the claimed wave length of 365nm and taught by Fourmun Lee (column 5, line 24) is a fixed intrinsic property of the silicon oxynitride material for the wavelength in question. As such Fourmun Lee implicitly anticipates the absorptive index at the wavelength in question.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to apply the gas control means of Felts et al for forming a layer of photoresist on the antireflective layer as taught by Fourmun Lee.

Motivation for applying the gas control means of Felts et al for forming a layer of photoresist on the antireflective layer as taught by Fourmun Lee is provided by Felts et al, and is drawn to "uniform film results and repeatability of film properties from substrate to substrate." (Column 10, lines 15-26).

Response to Arguments

10. Applicant's arguments filed March 11, 2002 have been fully considered but they are not persuasive.

11. With regards to applicant's position that the Examiner's statement:

"

In addition, as discussed by Felts et al (USPat. 4,888,199), the addition of He increases electron density in the plasma (column 10, lines 47-50) which anticipates the effect of reduced deposition rates considering the fact that these added electrons would effectively shield cations thereby reducing one of the chemical mechanisms of PECVD.

"

is "without merit", the Examiner again directs applicant's opinion to the very well established[4] relationship between a plasma (metal ion) deposition rate and the corresponding plasma's electron temperature/density relationship. By "adding electrons", as stated by the Examiner above and, again, supported by Felts et al, *anticipates* the effect of reduced deposition rates. This relationship is well demonstrated by M.K. Puchert et al in section IIc. - "Deposition Rate", and section V - "Discussion". In brief, M.K. Puchert et al state (section IIc. - "Deposition Rate", lines 4-5) that the copper deposition rate decreases "as the pressure and the ion current increase" (Figure 2, 4). Peripherally, M.K. Puchert et al *supports* the physical theory supplied by the Examiner - "The fact that the

[4]M.K. Puchert, et al, "Gas-plasma interactions in a filtered cathodic arc", *J. Vac.Sci.Technol. A* **10**(6), Nov./Dec. 1992, pp.3493-3497

deposition rate on axis falls to zero supports the view that the observed increase in the ion current is primarily due to an increase in the density of gas ions.", or, in other words, the increase in gas ions increases "collisional losses" (metal-electron) or, in the Examiner's words, a "shielding" effect.

12. Applicant's position that Felts does not suggest "controlling the gas delivery system to add a flow of an inert gas to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction of the selected deposition gases , the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas" is again inaccurate. Felts provides, as described above, a gas delivery system (item 15, Figure 1,2;col.3,lines 59--61) for delivering process gases (col.5,lines 3-40) into the process chamber and a controller (item 27, Fig.1;col.5,line 27 through the end of the patent) configured to control gas delivery system. The controller has a memory (column 10, lines 56-64) comprising a computer readable program (column 16 - column 46- Felts et al 4,888,199) having a computer readable program embodied therein for directing operation of the substrate processing system, the computer readable program including a first (column 5, lines 16-40) set of computer instructions (column 16 -column 46 - Felts et al- 199) for controlling the gas delivery system to introduce selected deposition gases (column 5, lines 17-40) into the process chamber at deposited gas flow rates. The deposition gas flow rates are further controlled by a second (column 10, lines 47-50; col.31 - Felts et al 4,888,199) set of computer instructions for controlling the gas delivery system to add a flow of an inert gas ("He",column 10,

lines 47-50; col.31) to the selected deposition gases at a flow rate previously determined to achieve a desired low deposition rate from a plasma enhanced reaction.

That the desired low deposition rate being lower than a deposition rate using the selected deposition gases at the deposition gas flow rates with a lower flow rate of the inert gas remains anticipated by Felts as demonstrated by M.K. Puchert et al as discussed on page 5 of this and the prior action. Specifically, with the addition of Felt's inert gas as helium (column 9, lines 10-13; column 10, lines 47-50), the partial pressures of all "selected deposition gases" will diminish and effectively "lower" or reduce the deposition rate. In addition, as discussed by Felts, the addition of He increases electron density in the plasma - "An increase of the inert gas supply provides more electrons, and a decrease in the gas fewer electrons." (column 10, lines 47-50) which anticipates the effect of reduced deposition rates considering the fact that these added electrons would effectively shield cations thereby reducing one of the chemical mechanisms of PECVD.

That the relationship between plasma vapor deposition and He electron density is known is further demonstrated by M.K. Puchert, et al:

M.K. Puchert et al state (section IIc. - "Deposition Rate", lines 4-5) that the copper deposition rate decreases "as the pressure and the ion current increase" (Figure 2, 4). Peripherally, M.K. Puchert et al *supports* the physical theory supplied by the Examiner - "The fact that the deposition rate on axis falls to zero supports the view that the observed increase in the ion current is primarily due to an increase in the density of gas ions.".

Not withstanding the demonstration of M.K. Puchert et al of the relationship between deposition rates and plasma electron density, there is provided further teaching by Felts of this very relationship and the above described control techniques for deposition rates:

"

The average electron temperature ("T_e") of the plasma effects the film deposition rate and properties of the resulting film, so it is an important piece of information to have in a real time plasma control system.

" (column 2, lines 47-51)

"

The module **121** also looks at T_e but in this case adjusts the helium gas flow to the plasma chamber. An increase of the inert gas supply provides more electrons, and a decrease in the gas fewer electrons.

" (column 10, lines 47-50)

"

The plasma variables are then manually adjusted until the average electron temperature corresponds to that which has been determined to be necessary for obtaining the desired film properties or rate of deposition of the film on the substrate.

" (column 1, lines 45-50)

As such, there is a clear connection between what Felts describes as the helium gas flow rate and the deposition rate through the monitored electron temperature.

13. With regards to applicant's position that Felts '199 does not teach or suggest computer instructions... (page 9), applicant is directed to columns 16-46 for the computer instructions and to the body of the above claim rejections for claims 44 and 45 for specific locations in the Felts patent teaching the claimed invention.

14. In response to applicant's argument that Puchert et al is nonanalogous art, it has been held that a prior art reference must either be in the field of applicant's endeavor or, if not, then be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for rejection of the claimed invention. See *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). In this case, Puchert resides in the field of applicant's endeavor ("growth conditions of thin films" Section VI. Conclusion) and is reasonably pertinent to the particular problem with which the applicant was concerned, particularly film deposition control from plasma gas (Section VI. Conclusion). Further, both Puchert and Felts teach the relationship between deposition rates, electron temperature, and helium pressure (discussed above for Felts, Puchert - Figure 5).

15. With regard to Applicant's argument regarding the rejection of claims 53, 57, and 58-59, the Examiner has provided a statement of motivation for increasing the taught ratio taught by Felts et al (USPat. 5,365,665) to meet the combined flow rate of SiH_4 and N_2O of at least 6.25:1 is drawn from the Thomas S. Dory discussion - "control of film properties, as expressed by the refractive index (N_f)." (Col.3, lines 45-48), and "Thus for a given pressure and DTBS flow rate, increasing or decreasing the NH_3, N_2, N_2O, or NO flow rate changes the Nf of the film." (Column 3,lines 48-51).

Yet Applicant has not contested the position of the Examiner that apparatus claims must be structurally distinguishable from the prior art. See MPEP 2114. Additionally, Applicant has not contested applicant's burden to prove the established results are unexpected and significant. See MPEP 716.02(b)[5].

16. Regarding Applicant's position concerning Lee not teaching "an odd multiple, greater than one, of the wavelength" and having film attributes of thickness and refractive index where the phase difference between reflected radiations "is at least 3 multiplied by 180° out of phase" is considered, yet Lee provides teaching and motivation of "phase-shift " layer attributes of thickness "d" and index of refraction "n" to "achieve the optimal phase shift of 180° " (column 5, lines 10-25). Additionally, those of ordinary skill in the art know that odd multiples of 180° produce the same effect for "constructive and destructive interference" for "improved resolution and improved depth of focus" (column 1, lines 43-48). For example, Lee discusses "conventional method of dealing with diffraction effects in optical photolithography is achieved by using a phase-shift mask....Typically, phase-shifting is achieved by passing light through areas of a transparent material of either differing thickness..." (Column 1, lines 32-45).

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[5]In re Boesch , 617 F.2d 272, 205 USPQ 215 (CCPA 1980)

Conclusion

17. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

18. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Examiner Rudy Zervigon whose telephone number is (703) 305-1351. The examiner can normally be reached on a Monday through Thursday schedule from 8am through 7pm. The official after final fax phone number for the 1763 art unit is (703) 872-9311. The official before final fax phone number for the 1763 art unit is (703) 872-9310. Any Inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Chemical and Materials Engineering art unit receptionist at (703) 308-0661. If the examiner can not be reached please contact the examiner's supervisor, Gregory L. Mills, at (703) 308-1633.

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